DOCUMENT RESUME

ED 280 446 IR 012 582

AUTHOR Hebenstreit, Jacques
TITLE Computers in Education in Developing Countries.
INSTITUTION United Nations Educational, Scientific, and Cultural Organization, Paris (France). Div. of Structures, Content, Methods and Techniques of Education.
REPORT NO ED-84/WS/10
PUB DATE Sep 84
NOTE 33p.; For a report on computer use in developed countries, see IR 012 580.
PUB TYPE Information Analyses (070) -- Viewpoints (120) -- Reports - Descriptive (141)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Change Strategies; *Computer Assisted Instruction; *Computer Literacy; *Computer Managed Instruction; Computer Software; Cultural Context; *Developed Nations; *Developing Nations; Educational Policy; Foreign Countries; Microcomputers; Policy Formation; Teaching Methods

ABSTRACT

Arguing that computers in education are necessary to prepare children to live in a future computerized society, this report examines the issues associated with computers in education in developing countries. The first of three parts provides a brief overview of how and why computers are used in education in developed countries; describes computer-assisted instruction (CAI), teacher-assisted instruction (TAI), and computer-managed instruction (CMI); discusses both technical and pragmatic approaches for teaching computer literacy; describes problems relating to hardware, software, teacher training, and evaluation; and briefly reviews arguments advanced in support of computer use in schools. The second part reviews the implicit factors that exist when computers are introduced and used in education in developing countries, including environmental, educational, and technological problems. The last part discusses problems that are specific to developing countries in the formation of policies and strategies for professional training, the use of computers in schools, selection of hardware and software, teacher training, and research. While the use of computers in education in developing countries is advocated as a means of decreasing the gap in level and quality of education between developing and developed countries, the importance of taking into account the cultural and general background of each country when developing policies is emphasized. (DJR)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

Division of Structures, Content, Methods and Techniques of Education

ED-84/WS/10
Paris, September 1984
Original: English

UNITED NATIONS EDUCATIONAL
SCIENTIFIC AND CULTURAL ORGANIZATION

COMPUTERS IN EDUCATION IN DEVELOPING COUNTRIES

by

Jacques Hebenstreit
Head of the Department of Computer Science
Ecole Supérieure d'Electricité
Plateau du Moulon
91190 Gif/Yvette (France)

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Suzanne Adlung

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Unesco, Paris

Reproduced by permission of
UNESCO

ED-84/WS/10
Paris, September 1984
Original: English

UNITED NATIONS EDUCATIONAL
SCIENTIFIC AND CULTURAL ORGANIZATION

COMPUTERS IN EDUCATION IN DEVELOPING COUNTRIES

by

Jacques Hebenstreit
Head of the Department of Computer Science
Ecole Supérieure d'Electricité
Plateau du Moulon
91190 Gif/Yvette (France)

Study prepared under contract with Unesco

COMPUTERS IN EDUCATION
IN DEVELOPING COUNTRIES

by J. HEBENSTREIT

ABSTRACT

This report is divided in three parts.

In the first part there is a short description of how and why computers are used in education in developed countries.

The second part is a review of the main specific problems which exist when computers are introduced and used in education in developing countries.

The third part does investigate the main difficulties of defining policies and strategies for the introduction of computers in education in developing countries.

THE INTRODUCTION OF COMPUTERS IN EDUCATION IN DEVELOPING COUNTRIES

PROBLEMS AND STRATEGIES

by J. HEBENSTREIT

1.- The use of computers in education in developed countries

The possible uses of computers in education have been investigated as a research subject as early as the beginning of the sixties and mainly in the USA. However during the next ten years (1960-1970) very little has happened in practice except some small scale experiments.

The main reason of the absence of computers in education at any significant scale during that period is not the absence of interesting results in research but the very high price of main frame computers during that period which made the idea of introducing computers in schools completely unrealistic.

Around 1970, the advent of low-end minicomputers in time-sharing mode made some small-scale experiments financially possible as is shown by the first French experiment (1970-1978) and the National Development Programme for Computer Aided Learning (1973-1978) in the UK.

Finally in the late seventies, the advent of the low-cost microcomputer has opened a whole new era. Because hundred of thousands of microcomputers are now going into industry, commerce and administrations, the society at large and the governments are becoming aware that the use of computers in education is becoming a real and urgent problem. Therefore, in many countries there are now incentives to promote the use of computers in education.

The use of computers for Computer Aided Instruction (CAI)

A number of different techniques are used today in CAI :

a) the tutorial mode

In this mode the computer is playing the role of a teacher. The subject of the lesson to be taught is divided up in small parts (items) organized in logical order. Each item is presented on the screen as a page of information. In the next page a question is asked on the item just presented and the student has to give an answer. If the answer is correct, the next item is presented; if the answer is not correct, more detailed information on the subject is given to the student on the screen and a new question is asked and so on until the end of the lesson. This mode is also called the programmed-learning-mode. In principle any lesson can be taught that way with very little help from the teacher. In fact it has proven very difficult to write good educational software for this mode because of the different ways of learning or the different learning abilities of individuals. Therefore the presence of the teacher is still necessary but his role is changing because he can look primarily after those learners who have problems.

b) the drill and practice mode

In this mode the computer proposes a series of exercises of increasing difficulty. As in the tutorial mode, if the answer to an exercise is correct, the computer proposes the next exercise and if the answer is not correct a series of exercises of intermediate difficulty is proposed by the computer.

In many cases the tutorial mode and the drill and practice mode are mixed in the sense that after presenting a piece of information (a grammatical rule or a rule in arithmetic for instance) the computer proposes an exercise instead of asking a question. The difficult part of in this method is the analysis of the student's answer because there may be more than one correct answer.

c) the simulation mode

This mode is mainly used for the teaching of experimental sciences (biology, physics, chemistry, etc). The set of equations describing the behaviour of a system is given to the computer and when the student types the value of the

input the computers shows immediately what the output would be. This method, widely used in industry for production purposes, allows the student to get in school a working knowledge of devices or situations which he could hardly manage in a real experiment.

This method is very popular in the teaching of experimental sciences.

d) the teacher-assisted mode

In the three above-mentionned modes the computer is used to assist or help the learner either by allowing him to learn at his own pace or by allowing him through simulation to make experiments which would not be possible otherwise.

There is also a mode in which the teacher uses the computer to assist him in his teaching activities.

The teacher can use the computer for presenting on a screen a great number of neat drawings instead of a few approximate drawings on the blackboard (if the screen is too small, the classroom can be equiped with a number of TV monitors to duplicate what appears on the screen of the microcomputer). The teacher can also put a problem on the screen and ask the class for a solution; if the proposed solution is a wrong one, instead of saying "this does not work", the teacher can introduce the proposed solution through the keyboard and show what happens if that wrong guess is implemented. This creates a new kind of relationship between the teacher and the class and also a new type of pedagogy where a wrong answer is not wrong because the teacher says so but because the computer shows that the proposed guess is not the right solution.

The computer managed instruction (CMI) mode

In this mode the computer is not used as a teaching or learning device but as a tool to manage the learning-teaching process or said differently the computer plays the role of a pedagogical tutor.

In practice when a student wants to learn a given topic, the student goes to the computer and types in the subject. The computer asks then questions about the part of the student's background which is relevant to the subject. After proposing a number of tests which have to be answered, the computer gives an automatic grading and asks the student to complete in one or two weeks a set

of tasks (reading books, going to lectures, drills and exercises, etc). After that period the student comes back to the computer, is graded through a set of questions and exercises and is given an assignment for the next period of time.

This mode of use of computers looks very exciting but no such system does presently exist. There are a small number of experiments going on in the US, the UK and Japan with systems having functionalities which are only a subset of what has been described.

Computer literacy

In most countries there is a feeling that we are going towards a "computerized society" i.e. a society where computers are going to play a fundamental role in all professional activities and also in private homes. This is sometimes summarized in the expression "a computer on every desk".

Many main frame computers are already used in developed countries but the advent of the cheap microcomputer on one hand and the advent of digital communications on the other hand have suddently increased the speed of installation of computers in industry, commerce and administrations (computer aided design and manufacturing, text processing, real-time management, availability of an increasing number of data banks, electronic mail, electronic fund transfer, etc).

There are therefore many proposals to introduce computers in schools not only because it may improve the present education through CAI but also because it is thought that all citizens should be "computer literate" (familiar with what a computer is, how it works and what it can do).

There are however two different approaches of how to teach "computer literacy" in schools.:

a) the technical approach

In its most extreme form this approach is advocating that children should have a working knowledge of how computers work and learn how to write programs including a detailed knowledge of algorithms, data structure, recursion, etc. The main argument of this approach is that informatics is a new, autonomous science and its importance is such that it should be taught as a new discipline in schools; the other argument being that sooner or later everybody will have

to write programs and therefore a working knowledge of computers is necessary. In its mildest form it is proposed to give to children a series of lectures with a general information content on computers, how they work and the social impact of their use.

b) the pragmatic approach

This approach advocates that even if informatics is a science, it is a science in the making and the only thing we could teach is merely the result of today's technology. Computers, programming languages and programming methods have already changed over the years and are still changing rapidly so that what we would be able to teach today in informatics would most probably be completely obsolete in ten years from now when today's children will be active adults. Nobody knows today which parts of informatics are going to last and which parts will become obsolete but on the contrary it is evident that the services already available today on computers like text processing, spread sheets, aided design, etc, are here to stay and to develop whatever the evolution of informatics and the evolution of computers and programming languages.

Moreover the present programming languages have been designed to allow humans to communicate with a machine (the computer) so that training in programming is in fact, today, training "to think like a machine" whereas it is said more and more often that education should promote qualities which machine will never have i.e. intuition, imagination, creativity which will, more than ever, be necessary in the world of tomorrow where the use of computers will allow people to tackle more and more complex problems. Finally the announced objective of the fifth generation computer which will allow people to communicate with computers in natural language, will make all programming languages obsolete for all users except the specialists in informatics who will have to write the necessary software. In this approach the use of computers in education has a double aim :

- to use CAI to improve education,

- through that very use, familiarize children with the different services available on computers (using data-banks to teach History and Geography, using simulation with graphics to teach experimental sciences, using spread-sheets to teach mathematics, etc) their possibilities and their limits.

The policy regarding computer literacy depends on the country and does even vary in time in certain countries. In the UK, the NDPCAL (National Development Programme for CAL) project (1973-1978) was explicitly aimed at the implementation of CAI whereas the MEP project (Micro-electronics in Education Programme) for 1981-1984 is mainly orientated towards computer literacy.

In France the "58 lycées" project (1970-1978) was specifically aimed at CAI while the "100.000 micros" project (1983-1988) includes an optional teaching of informatics for the 15-18 years old on an experimental basis.

In the USA the teaching of informatics and/or computer literacy have been popular there for years but the very content of "computer literacy" is changing progressively as can be seen from the headlines of the Proceedings of the recent Conference on "National goals for computer literacy" i.e. : computer literacy in the mathematics curricula, in the science curricula, in the social studies curricula, etc, where the connotation of application areas is emphasized.

In many countries there is however a considerable pressure from parents to have programming taught at school because they believe that it will make it easier for their children to find a job or a better job, which is wrong because what employers ask for, outside the informatics industry, is a working knowledge of computer applications while inside the informatics industry what is required is a qualification based on two or three years specialized vocational training in informatics.

In many countries there are also efforts to disseminate computer literacy to the whole population.

In the UK there is a very popular series at the television on computer literacy whose net outcome has been that over 100.000 british made microcomputers have been sold for private use in homes.

Such series do exist in the US and Japan and are planned for 1984 in France.

Moreover different strategies are used in different countries to spread computer literacy in the public (microcomputers in airports, exhibitions and museums or, for example, the French X2000 project to open in the next few years 1000 centres over the country where people can go for free information or advices).

The hardware problems

Despite the low price of microcomputers (as compared to main-frames), their introduction in the educational system rises a financial problem because of their number. In most countries the school population is about 25% of the total population and to have a significant impact on education this implies to install microcomputers by the millions.

Because it is a tremendous potential market for the manufacturers the hardware problem has become in most countries a political problem.

Except the USA (because they manufacture 70% of the world production of computers), in most countries there are policies to encourage buying computers manufactured in the country (UK, France, Japan, Federal Republic of Germany, etc) mainly when these computers are bought with governmental funding. In some countries which do not have a national computer industry, efforts are made to start such an industry based on the school market (Brasil, New-Zealand, Australia, etc).

In the USA the existence of this school market has started a competition between companies which either propose heavy discounts if the computers are bought in great number by a school or propose to give computers free to schools provided the government agrees on tax-exemptions for the company.

Official funding policies for buying hardware for schools varies widely from country to country depending partly on the administrative structure of the country and of the structure of the educational system.

Two extreme examples are the UK where the Micros in School project (Ministry of Industry) pays half the price of a microcomputer bought by any school provided the computer is chosen between two british-made models with the aim of having one micro in each of the about 30.000 elementary and secondary schools and France where the computers are completely paid through official funding at the rate of 8 micros in each school with the aim of having 100.000 micros in elementary and secondary education in 1988.

In federal countries and in those where private schools are an important part of institutional education, funding is national or regional and/or local depending on circumstances.

The software problems

A few years ago there was no educational software problem because, as already said, most of the uses of computers in education were experimental and in that time researchers were writing their own software for their own use.

As the number of computers in education began to increase it became evident that it dit not make sense to ask each teacher using a computer to write his own software (current evaluation is 200 to 300 hours of work to write a one-hour-interaction programme).

However private companies were reluctant to enter the market of educational software for a number of reasons (the small number of computers in schools made the market too small to be able to sell products at a price level compatible with what schools could afford, impossibility to predict or to guess the number of copies sold in a given time, necessity of having as many versions of each programme as there are computer models and/or programming languages, no provision for software in any school budget, etc).

Therefore in many countries the process has started through local initiatives mostly in computer science departments of universities where the manpower was paid through research contracts with more or less official funding (National Science Foundation in the USA, NDPCAL project in the UK, off-duty time given to trained teachers in France, etc).

It is only quite recently that private companies (mainly book-publishers) have started to invest in this area, asking interested teachers to propose detailed pedagogical scripts and hiring computer specialists to write the software and an increasing number of software package is becoming available.

In France there is a competition between private companies and a government-funded institution (Centre National de Documentation Pédagogique) which centralizes all the educational software written by teachers and gives away free a copy of it to any school asking for it.

For the time being most companies believe that the real market for educational software is the home-computer market and try to enter that market by developing "educational games".

For all these reasons the amount of available educational software is very small and will probably remain so at least as long as the production of educational software will remain a "cottage industry".

The teacher-training problems

In some places there is a feeling that there is a teacher training problem only when teachers are asked to teach informatics or computer literacy.

This is true of course but it is not the full picture. Even if there is no teaching of informatics or computer literacy but only the use of educational software there is still a teacher training problem and this is perhaps a more difficult problem.than the previous one because it is rather easy, in terms of content of the training, to teach about computers and their use (there are already well-established curricula for that purpose at least for professionals) whereas it is extremely difficult to teach about the proper pedagogical use of computers in the classroom for the very simple reason that there is no previous experience on which to rely.

It has been said that computers can improve education if they are used at the right place, at the right time, with the right amount and in the right way but to meet all these conditions teachers have to be trained to use the computer that way.

The mere presence of computers in schools does not guaranteethat education will be improved and the unskilled use of computers in education can even produce worse results than not using them at all.

While heavily emphasized in the Carnegie Report on "The fourth revolution" as early as 1972 the prerequisite of teacher training before starting activities in CAI has only been slowly recognized. The reason of this slow recognition is probably that the idea of teacher training because of technological progress has appeared as something new in institutional education in most countries and also perhaps the scale and the difficulties of the problem. Whatever the reason for that slow recognition of the problem, teacher training is today almost everywhere an important part of any plan to introduce computers in education. In the UK, in the 14 regions in which England has been divided for the MEP project, there are a variety of courses available in each regional centre : a three days course, a one week course,

a three months course and a teacher's teacher course and some of these courses are compulsary for at least two teachers from each school which buys a computer at half the price with the help of governmental funding.

In France, in each school which receives a package of eight microcomputers paid by the government there is a 12 days course in that same school to which all teachers are invited. Moreover 20 centres have been created in universities where about 600 teachers are trained each year during a full academic year to become either teacher's teachers or authors of educational software. About 20.000 teachers have already been trained through this scheme.

The costs of teacher training are impressive. In France from 1970 to 1978 about 2 million dollars have been spent for that purpose which have risen to about 5 million dollars in 1981-1982 and equivalent sums have been spent in the UK. In France in 1983-1984 about 20 million dollars will be spent to train approximately 20 000 teachers.

Evaluation problems

As already said, CAI activities as well as teaching of computer literacy has been heavily funded through governmental aids in most countries.

These financial efforts have been made by governments with the aim of improving education through the use of computers and as a consequence in most countries, committees were set up to investigate and try to evaluate how the funds were spent and what kind of improvements have resulted.

These "evaluation reports" should normally compare the results of teaching with and without computers and try to draw conclusions on the impact of the use of computers in education.

In fact most of these reports discuss the financial and quantitative results of the experiments (how the money was spent for hardware, software, training, staffing, etc, and how many computers were bought, how many software packages were written, how many teachers and how many students were involved, how many hours students spent weekly on a terminal, etc).

In those parts of the reports dealing with the pedagogical changes induced by the use of computers the emphasis is mainly on what is changing in the classroom (changes in the attitude of the teacher, changes in the behaviour of students, changes in the content of what is taught, etc) much more than

on the strict comparison between the same course taught with and without a computer.

This very content of the reports shows convincingly that this kind of comparison which was considered as the justification for CAI in the sixties, is considered today as an exercise of academic interest only and that the problem is elsewhere.

It is considered today that the use of computers in education :

- allows pedagogical strategies which could not be used otherwise,
- allows to teach subjects which could not be taught otherwise,
- allows through proper use of CAI to familiarize students with the main applications of computers (graphics, simulation, text processing, data banks, etc),
- allows students, at a given age, to handle more complex subjects and problems,
- allows improvements in the autonomy and creativity of the students,

All these changes are almost impossible to evaluate because of the absence of a proper term of reference the changes being so drastic in terms of content and methodology of teaching that the state of the art of the present day teaching is not felt to be the right term of reference.

This is probably the reason why in most reports, the use of computers in education is much more justified by the necessity to adapt the educational system to the "computerized society" of tomorrow than by evaluating the improvements brought to present day education.

Conclusion

The use of computers in education has been investigated since the early sixties.

Some limited experiences have been made in schools during the seventies but the price even of minicomputers was too high to make a generalized use of computers in education possible.

However the birth of the microcomputer in the late seventies has led a number of governments to set-up ambitious projects for the introduction of computers in education with the double aim of improving education and to use the educational market as a basis for the development of a national industry in microcomputers and in educational software.

Whereas in the sixties and seventies the main argument for using computers was that CAI was less expensive and/or more efficient than traditional education, the fast invasion of the developed societies by microcomputers is changing the argumentation.

Therefore it is argued today that computers in education are necessary to prepare children to live in the future "computerized society" and the concept of computer literacy is therefore emphasized with a great importance given to teaching informatics and mainly programming to all children.

Finally because the use of computers is becoming more and more "user oriented" or "friendly" (the communication with computers in natural language is a very active subject in research) there is a strong tendency to use computers in CAI in modes which allow children to become familiar with the use of computers in various applications (graphics, simulation, spread-sheets, data banks, text processing, etc) the teaching of informatics in schools being left as an optional subject.

Moreover it is felt that the use of computers in education is going to give all children more and more powerful tools (in the form of increasingly sophisticated software packages) and the use of these very tools will in turn lead to successive up-gradings of all curricula in schools.

All in all, computers are going to be used increasingly in education. However it should be kept in mind that for the moment being computers are used in education at a very small scale in any developed country : in terms of total school population the rate varies from one computer for a few hundred children to one computer for a few thousand children depending on the country.

2.- The use of computers in education in developing countries

Computers have been introduced in education in developed countries :

- to improve education,

- to prepare children to the "computerized society" of tomorrow,

but the perspectives, the techniques, the methods and the objectives of that introduction have implicitely taken into account the general background (educational, social, technological, etc) which exists in developed countries.

There are therefore many implicit factors which have played a basic role in the shaping of the experience accumulated during the introduction of computers in education in developed countries.

This implies that the accumulated experience in developed countries in terms of policies and products cannot be simply transfered is it stands to developing countries with their wide spectrum of different general backgrounds, without serious risks of failure.

There is unfortunately no such thing as a universal method for introducing computers in education and therefore any country wishing to introduce computers in education should start from the general backgroung and the educational problems of the country to thoroughly and carefully analyze the experience accumulated in developed countries to determine how that experience and which parts of it can be used for the definition and development of a national policy.

The environment problems

In developed countries children are brought up in an "industrial environment" where they get familiar with all kinds of more or less complex machines either by seeing them operated by others or by using them : electric can openers, vaccum cleaners, washing machines, vending machines, videogames, electric and electronic toys, lifts, escalators, cars, trains, planes, etc, are parts of their daily life.

That same industrial environment is a constant source of messages (in printed form or picture form) or signals (flashing lights, traffic lights, etc) which children learn naturally to decode and interpret correctly in terms of their environment.

The whole educational system in terms of curricula content and in terms of pedagogical strategies takes implicitely into account the kind of knowledge or specific intellectual abilities children have already acquired through their experience before they go to school.

An interesting and real life example is the following : an elderly teacher trying to explain the action of a millstone gave as a practical example the mechanism of the hand driven coffee grinder. The whole class stared at the teacher without visibly understanding what he meant. After a while one of the children raised his hand and said "Oh yes I see what you mean , I have seen one of these things in my grandmother's kitchen". The teacher had simply forgotten that the only coffee grinders used in homes for years are electrical grinders where the grinding mechanism is a high speed rotating knife, the hand driven mechanical coffee grinder being much more expensive and available today only in shops selling antiques.

These same cultural differences show up when it comes to the use of computers in education :

- the use of a keyboard is easily mastered by most children from developed countries as they have a wide practical experience of pushing all sorts of keys and buttons in their daily life,

- the texts and pictures presented on the screen of a terminal as well as the questions a student is asked during a session on the computer have been designed by the author of the educational software package with the implicit assumption that the student has the kind of "industrialized society background" already mentionned. Under these circumstances it becomes evident that the decoding or interpretation or understanding of the presented texts, pictures and questions will in many cases be different from the authors assumptions when the package is used by a student with a different cultural background and the whole package will therefore appear as inefficient or, in some cases, as a complete failure.

The implications of these "environment problems" will be discussed later on under the heading "software problems".

The educational problems

The educational system of any developed country, when considered from a global point of view, does approximately respond to the needs of the country. The educational system of any developed country is traditionally criticized in terms of costs, efficiency and adequacy but globaly all these systems turn out each year the approximate amount of manpower at all levels of competence required to keep the economy of the country going.

Therefore the observed changes in the educational system in a developed country are much more a problem of evolution or partial adjustments to meet the changes observed or predicted in the country or in society at large than a problem of major efforts to overcome the kind of difficult and massive problems which exist in developing countries.

This remains true for the introduction of computers in education which, in developed countries, aims mainly, as already stated, to improve education and to adapt it to the "computerized society" of tomorrow whereas the right question to ask in developing countries is how can the use of computers in education help to improve and adapt their educational systems which may appear to be the same problem but which.are in fact different problems because they are formulated in different contexts (to improve education is a different problem in a country where there are enough teachers at all levels in all schools and in a country where there is a lack of teachers or where adult alphabetization is a major concern).

That is why what has been said in the first part of the report about the different modes of use of computers in education should not simply be transfered to developing countries but should be analyzed and reappraised in the light of the context of each country.

It has been said, for instance that the tutorial mode is not very popular with teachers in developed countries except as a remedial help for low-achieving children but the reason of that appraisal is that there are

enough teachers. In a country where there is a lack of teachers what kind of help can be expected from the use of the tutorial mode to replace the missing teachers ? is it worse or better than no teacher at all ? and even more, can the tutorial mode be used for autonomous teacher training if there is no other possibility ? This kind of question has never been investigated in developed countries for the very simple reason that these problems do not exist in developed countries.

Therefore, if the answer to the preceding questions is yes, who is going to define the content of the necessary educational software packages to make sure that they do fit the cultural background of the users of the packages ?

Specialists from developed countries have little competence in that last area but their general experience can be used through cooperation with national educational authorities from developing countries which have the competence to decide what is and what is not adapted to their national cultural background in terms of pedagogical strategy.

The software problem

As already mentioned, educational software packages designed in developed countries carry with them, implicitely, the general background of these countries and should not be used without caution in developing countries for a number of reasons :

- the packages are written in a specific programming language and impose very frequently the use of a specific type of computer which may be more or less well adapted to local needs,

- if they are used in a country with a very different general background there are two difficulties :

  The first difficulty is a possible lack of efficiency of the packages due to the misadaptation between the content of the packages and the general background of the user.

  The other difficulty is a more subtle one and perhaps a less visible one. The educational system of a country is the place where national culture and traditions are transmitted to the young generation. Willingly or not,

the educational software designed in a country carries with it, in many subtle ways, the social and moral values of the culture of that country and therefore the massive use of educational software designed in a foreign country will slowly but inevitably lead to a transformation and eventually to a decline of the originality and specificity of the national culture and traditions. This kind of difficulty is already well known regarding school books or books in general but it is much more difficult to analyze in the case of interactive educational software packages.

The ideal solution of these problems is of course to design locally the educational software packages to be used in a country or to use packages from countries with more or less analog general backgrounds. This is not possible for the moment because of the lack of specialists in most developing countries but a cooperation with specialists from developed countries can help tremendously to overcome the mentionned difficulties and to start local production of educational software. More will be said on that subject under the heading "teacher training". There is at least one more software problem. which is at the same time a financial and a technical one. All software packages are covered by some form of copyright which makes it illegal to make a copy. This implies that it is necessary to buy as many copies as there are computers. Is is however possible in some cases to make a licensing agreement through which copying becomes a legal activity and this would probably be a good solution for developing countries because it would allow to create national centres in charge of the copying activity thereby initiating a technical activity related to the educational use of computers, including a group in charge of rewriting the accompanying technical and pedagogical documentation to adapt it to the national background and environment.

The teacher training problem

As already stated in the first part of the report, teacher training is considered in developed countries as a prerequisite to any introduction of computers in education. More and more warnings are given to schools not to buy computers or even not to accept computers as gifts unless they know exactly what they are going to do with them. It has also been said that teacher training is a necessity whether these teachers are intended to teach a new subject as computer literacy or whether they are intended to use the computer as a pedagogical tool in their normal teaching activity.

The training of teachers is as important in developing countries as it is in developed countries (there are examples of computers bought by schools in developed countries and which have never been used for the simple reason that the teachers don't know how to use them or don't see any reason to use them) however the problem of training teachers in developing countries is different from that same problem in developed countries because the contexts are different.

First of all in developed countries there are specialists in computer science available, even in those countries which do not manufacture computers, because curricula in informatics do exist in universities for a number of years and it should be kept in mind that the initial work on CAI has started in the informatics departments of universities.

In most countries some of these specialists have been used as staff for teacher training at least at the beginning. This had some drawbacks because these specialists had a natural tendency to teach their own discipline (i.e. informatics) without paying sufficient attention to the training in the pedagogical use of computers but is helped to start the process.

It is true that in developed countries there is a relative lack of specialists in informatics, but the situation is considerably worse in developing countries and therefore the problem of finding the staff for teacher-training is much more critical.

It is not only critical because teacher training is a prerequisite for the effective use of educational software, it is also critical because teacher training is also a prerequisite for starting a national production of educational software (the cultural importance of that activity has already been stressed in the paragraph on the software problems).

More will be said on teacher training in the paragraph "Policy problems".

The hardware problems

Some of the hardware problems are common to developed and developing countries because they are purely technical problems :

- There is a great variety of models of microcomputers and they are incompatible between themselves : they don't have exactly the same programming languages nor the same operating systems (a software package which runs on one model does not run on another one), or the same standards even inside the same company depending on the model,

- Each year some companies disapear while others are created so that after some time there are no maintenance nor spare parts,

- Every year more sophisticated models are available (high resolution graphics, color screens, touch-sensitive screens, flat screens, sound, network connexion possibilities, "mouse", joysticks, connexion to video cassette recorders and video disks, etc),

- There is now a wide spectrum of models available from 60$ (using a television set as a screen) to over 6000$ (including printer and hard-disks) and rises the question of which model to buy for education.

However there are other problems for developing countries :

- How does a given model resist to certain local enviromments (heat, humidity, insects, etc),

- How does a given model behave in presence of variations in voltage and frequency of the electrical network,

- No microcomputer with a floppy disk a cathode ray tube and a printer can run very long on batteries and moreover batteries are very expensive and not always readily available,

- Maintenance can be a very critical problem outside of big cities and even in big cities when the manufacturer does not have a permanent local representative.

All these problems make the choice of a microcomputer for education something very difficult and all the mentionned aspects should be carefully investigated before making a decision.

3.- Policies and strategies

The introduction of computers in education at any level (schools, technical training institutes and universities) and whatever the purpose (general computer literacy, improvement of education or training of specialists in informatics) requires a long term policy because any educational system reacts rather slowly to policy changes (a reaction-time of a few years is typical).

The increasingly massive use of computers in developed countries has been possible because of the existence of professional levels of training in informatics and is in turn pushing the developed countries to increase their effort to introduce computers in general education.

The main axes of the applications of informatics in education

As already said, the policy of introducing computers in education in developed countries has been a kind of three-step policy :

1) Training specialists in informatics at the level of a Master degree or Engineering degree and simultaneously at the vocational level (analysts, programmers, maintenance).

2) Based on the existence of these specialists, the use of computers has spread to other departments and laboratories of universities (Electrical engineering, Physics, Chemistry, Biology, Management, Economics, etc).

3) The massive use of microcomputers in industry, commerce and administration which are increasing the productivity of manpower and will allow to produce cheaper, more sophisticated and more reliable products has lead to the decision to introduce computers at all levels of education starting with primary schools. But this last step in considerably facilitated by the existence of the two previous one.

It seems difficult to define a policy which does not include these three steps in the defined order because the implementation of each step is a kind of prerequisite to create the teaching staff for the next step.

In any country, therefore, the definition of a global policy depends strongly on the level of implementation of each step in the educational system of the country. However it should be possible to accelerate the process of introduction of computers in education in developing countries either through regional cooperation or through cooperation with developed countries.

Finally there are problems which are specific to developing countries like alphabetization, adult education or scarcity of teachers in various disciplines. These problems would probably be easier to solve through the use of computers but little has been done for the moment in this respect and more research is necessary to develop the right methods adapted to the different levels of development and to the different cultural background.

The professional training policy

The training of professionals in informatics at university level and at the vocational level has already started in many developing countries in parallel with the use of computers in these countries.

To define a policy in this area has become easier over the years because :

- the problem has been well investigated.
- there is an impressive number of existing curricula (including a UNESCO-IFIP curriculum).
- the content is a scientific and technical one and does not imply any reference to a cultural background.

Therefore the definition of a policy is a problem of resources in manpower, installation of the right equipment and evaluation of national needs of specialists over the next years. It does not mean that it is easy but the number of people involved as well as the cost of equipment is very low when compared to the problem of the general introduction of computers in education.

The use of computers in school education policy

In most developed countries (including the USA) there is no national policy for the introduction of computers in education at school level and it is happening most of the time because of local or regional initiatives.

However with or without a national policy the number of computer in schools has increased slowly over the last few years (300 000 in the USA, 14 000 in the Federal Republic of Germany, 9 500 in the United Kingdom, 8 000 in France in 1983 but 30 000 in 1984, 5 000 in Italy, 4 500 in the scandinavian countries and about 7 000 in the others European countries) and is increasing more and more rapidly, the objective being to have enough computers in the educational system to allow each student to use a computer for about one half hour a day. For the moment being there is statistically about 1 computer for every few hundred students or few thousand students depending on the country and the objective mentionned of one half hour day use per students implies that the present number of computers has to be increased by a factor between 10 and 50.

Moreover depending on the country about 20% of all installed computer will have to be replaced each year because a computer does not last more than 5 to 7 years. The costs involved may seem very important but they are meaningful only if they are compared to the total budget of education.

Such a study has been made in the USA for the current costs based on the assumption of 2,5 million computers in primary and secondary education (about 1 computer for 10 children). The result of the study (including the replacement of 0,5 million computers each year and the cost of the software to be changed every 3 years) is that the cost does not exceed per year about 1% of the total budget for primary and secondary education. This study has been criticized because it does not include the cost of maintenance and the cost of teacher training but it is interesting because it gives an order of magnitude of the impact of the use of computers on the total budget (the cost of education being a more or less constant part of the National Gross Product of any country - 4% to 6% as shown by UNESCO statistics).

For developing countries however these statistical results have to be taken with great care and reanalyzed in the light of their national economic conditions.

One important issue in deciding about a policy is to whether children should be taught technical computer literacy (structure of computers, programming, etc) or if the computers are going to be used as pedagogical tools including familiarization with the use of computers. Teacher training problems are not the same in both cases and more will be said about this issue under the heading "Teacher training policy".

Another important issue is where to start the use of computers in education (primary or secondary education). In most developed countries it has started with children at the age of 15-16, the rationale behind that policy being two fold : first, it was widely believed that at the age of 15-16, children were more able to cope with computers than at a lower age and second, only the most gifted or most able children continue to go to school at that age. One more reason (never officially stated) was that teachers in upper-secondary education have, in general, a higher academic degree and should therefore be easier to re-train.

There is no evidence that this kind of policy does systematically fit the needs of developing countries and the definition of where to start in the age-scale is an open issue.

Moreover, as already mentioned, there are problems which are specific to developing countries as alphabetization, adult education and a general lack of teachers.

The kind of priority to be given to the use of computers to solve these specific problems is also an open issue. Finally, even when priorities have been defined there remains the general problem of deciding the speed of development in each chosen direction which in turn depends heavily on the possibility of funding and the intrinsic slowness of reaction of the educational system.

The hardware policy

The main hardware problems have already been mentioned (physical environment, maintenance, non-portability of software between different types of computers, etc).

Some more problems should be investigated before defining a hardware policy like, for instance, the availability in a near future of "multimedia computer-based devices" like the computer controled video disk including sound and speech at prices which are competitive with the stand-alone microcomputer.

Another aspect which could influence the definition of a policy is the existence of a national telecommunication network which could be used for down-loading educational software directly from central or regional computer to the local microcomputers through telephone lines or give access to regional or national educational data banks, etc.

Finally in some countries, the introduction of computers in education could offer a possibility of starting a national activity in microcomputer manufacturing through licensing or arrangements with the equipment manufacturer as it is already the case in other industries like automobile or avionics. Much depends of course of the availability of qualified manpower or the possibility of training existing manpower for that purpose.

The software policy

Professional softwares (for data processing or scientific calculations) are more or less universal in the sense that their use in any country requires only small local adaptations and this is even true for softwares which are more sensitive to local differences like text-processing (there are differences in the required keyboards for English, French, Swedish or Russian but this has been taken into account during the design process and necessitates only small changes in the equipment or the software).

Educational software on the contrary is mainly composed of texts to be presented to the student and of questions the student has to answer. There is therefore a language barrier as soon as the software is used in a country speaking a different language.

However the importance of the market and the demand for educational software is such that in many countries, educational software is imported and translated in the national language.

It has already been emphasized in the paragraph on "Software problems" that there are two important issues regarding imported software :

- Any educational software, even translated, is an implicit vehicle of the cultural values and traditions of the country where it comes from. Therefore the massive use of imported educational software can become, if it is not carefully controlled, a certain form of "cultural colonization".

- Any educational software has been designed by its author with a number of implicit assumptions of the cultural background of the future user. It the user has a different cultural background from the assumptions made by the author the software will prove inefficient or can even be a complete failure.

Therefore educational software should be designed in the country where it is going to be used or at least in a country with about the same general background and with more or less analog cultural values and traditions.

The decision to start a national production of educational software is an important part of any software policy even if it has to start at a very small scale (pilot projects, national or regional centres, cooperation with specialists from developed countries are possible strategies to start such an activity).

Because few specialists are available in developing countries, a national activity in educational software production is tightly linked to the teacher training problem.

The teacher training policy

We shall consider separately two aspects of teacher training :

- Training teachers to use computers in schools

  If the policy is to teach informatics in schools the training requires a rather long time (one month full-time seems to be a minimum) because the subject is a completely new and difficult one.

If the policy is to use computers as educational tools, the training can be much shorter (one or two weeks to learn how to connect and start a computer and how to execute an educational software package) provided each package includes a documentation giving a full description of how to use that package in pedagogical terms. The training can be largely a self training if specific software packages for teacher training are available or are developed for that purpose.

If computers can be used to teach children, they can also be used to train teachers. This aspect of the use of computers (using computers to teach teachers how to use computers in education) has been little investigated in developed countries and could be an important subject of research in developing countries.

- Training teachers in any discipline

Because there is a scarcity of teachers and even a greater scarcity of staff for teaching teachers in developing countries, the possibility to use computers for teaching teachers can be of great help in these countries.

This problem has been very little investigated in developed countries because the mentioned problem does not exist but it may help to solve the problem which exists in developing countries.

The best place to work on that problem are probably the institutions where teachers are normally trained.

Finally teacher training in the educational use of computers is a prerequisite of starting a national production of educational software. This however implies an in-depth training of a small group of teachers which could be the starting point of a group including these teachers, specialists in psychology and pedagogy and informaticians with the aim of starting the production of educational software.

Any teacher training policy should include the aims and scope of the policy, the number of teachers to be trained each year, the different levels of training with their objectives and an evaluation of the costs including the necessary equipment for the training.

Research policy

The use of computers in education will increase over the years and many problems related to their use are still open even in developed countries :

- Cognitive problems to be solved to improve the efficiency of the use of computers (modelling and structuring of knowledge, better understanding of learning activities, etc).

- The influence of technology on the curricula at all levels of education.

- Ergonomic aspects of the use of computers.

- Etc.

It has been emphasized many times that the use of computers in education in developing countries raise new and different problems and this implies the necessary definition of a research policy to investigate these specific problems.

4.- Conclusion

The introduction of the use of computers in education has started in developed countries a few years ago for a number of different reasons (pedagogical, social, economical, industrial, etc).

Progressively, often through trial and error, a methodology of use if emerging and the educational authorities are becoming aware of all the different implications (hardware, software, teacher training, research, curricula content changes, costs, etc).

For the first time in history technology is invading education and is going to change its methods and contents.

There is, without any doubt, a definite danger of an increasing gap in level and quality of education between those countries using massively computers in education and those which do not.

The use of computers in education in developing countries can however be a way of decreasing the gap, provided it is done through the careful definition of a policy taking into account the cultural and general background of each country and in cooperation with developed countries for the transfer of the already accumulated knowledge and know-how.

September 27, 1984 - JH/VC.

Also available on request:

Complete list of documents available free from the Division
Catalogue of Unesco publications
Sample copy and subscription information on
Prospects, quarterly review of education

For information, write to: Division of Structures, Content, Methods, and Techniques of Education (ED/SCM)
Unesco, 7, place de Fontenoy
75700 Paris. France